

Prenatal growth of Norwegian lemming *Lemmus lemmus* (L.)

EIVIND ØSTBYE AND OLDRICH GULT

Østbye, E. & Gult, O. 1980. Prenatal growth of Norwegian lemming *Lemmus lemmus* (L.). *Fauna norv. Ser. A*, 1, 1-4.

In a study of prenatal growth males and females from a laboratory breeding stock were paired until copulation and females were sacrificed in groups 5, 10, 15 and 20 days after conception. Altogether 33 pregnant females carrying 146 embryos were used. Mean litter size was 4.42. Length and weight measurements of embryo were used as criteria of age development of embryos and thereby giving a key to determination of the stage of pregnancy during field study autopsies. This key makes it possible to give a fairly accurate determination of age of embryos according to the crown-rump length, as early as 5 days after conception and by weight between 5 and 10 days.

E. Østbye & O. Gult, Zoological Institute, University of Oslo, Blindern, N-Oslo 3, Norway.

INTRODUCTION

The purpose of the present study was to find a method to determine the stage of pregnancy and prenatal growth when carrying out autopsies in field studies on small rodents. Small rodents have a very short pregnancy (around 21 days in most Norwegian species, including the lemming), and we propose using the prenatal growth of embryos indicated by length and weight measurements, as a key for macroscopical determination of the stage of pregnancy.

MATERIAL AND METHODS

Lemmings from a laboratory breeding stock originating from the Hardangervidda high mountain plateau, South Norway, were used in this study. Males and females were paired and sepa-

rated immediately after copulation was observed, visually or by the appearance of a sperm plug. The age determination is not in error by more than 8–12 hours. The females were sacrificed 5, 10, 15 and 20 days after conception, respectively. The uterus was immediately dissected out, and the embryos released. The crown-rump length of the embryo, lying on its side with all the foetal membranes, was then measured in the fresh state. The crown-rump length is here defined as the maximal length of the embryo.

After removing the membranes, the length was again measured, the embryo still lying on its side naturally stretched. It was then weighed, after gentle rolling on soft paper to remove embryonal fluid on the body surface.

The number of litters and their size at the different stages of pregnancy are shown in Table 1.

Tab. 1. Number of litters and embryos investigated.

Days after conception	Number of litters at different litter sizes							Number of litters	Number of embryos	Mean litter size
	1	2	3	4	5	6	7			
5	—	—	1	2	—	—	—	3	11	3.66
10	1	1	1	1	3	1	1	9	38	4.22
15	—	2	3	2	1	1	2	11	46	4.18
20	—	—	1	3	1	4	1	10	51	5.10
								33	146	4.42

Tab. 2. Crown-rump length and weight of embryos. (1: with foetal membranes, 2: with foetal membranes removed).

Age (days)	Embryo length ¹ (mm)					Embryo length ² (mm)					Embryo weight ² (g)				
	\bar{x}	SD	SE	range	n	\bar{x}	SD	SE	range	n	\bar{x}	SD	SE	range	n
5	3.6	0.92	0.26	2-5	11	not measured					0.05	0.00	0.00	0.05	7
10	8.1	1.82	0.28	5-11	38	7.7	1.31	0.20	5-10	36	0.2	0.17	0.00	0.1-0.5	37
15	16.6	3.69	0.53	10-24	46	16.5	4.05	0.59	10-14	46	0.7	0.44	0.00	0.1-1.7	45
20	25.4	2.89	0.40	20-32	51	28.5	3.15	0.44	21-35	51	2.7	0.76	0.10	1.4-4.6	51

RESULTS

Measurements of embryo crown-rump length, with and without foetal membranes, and weight without membranes are presented in Table 2 and Figs 1-3.

A measurement of embryo length without foetal membranes, was impossible as early as 5 days after conception, as the embryos were too small. Weight was impossible to measure in one litter for the same reason.

Mean embryo length and weight varied among the different litter sizes, but there was no tendency to smaller length or weight with increasing litter size (Tab. 3). However, the number of litter samples are too small to show significant differences between the different litter size groups.

DISCUSSION

The mean litter size was 4.42 (Table 1). Litter size of the Norwegian lemming in the field is reported to be about six (Wildhagen 1953, Koshkina & Khalansky 1962, Kalela & Oksala 1966), not taking into account age, season or phase of the population cycle. In other laboratory colonies mean litter sizes from 4.1 (Frank 1962), to

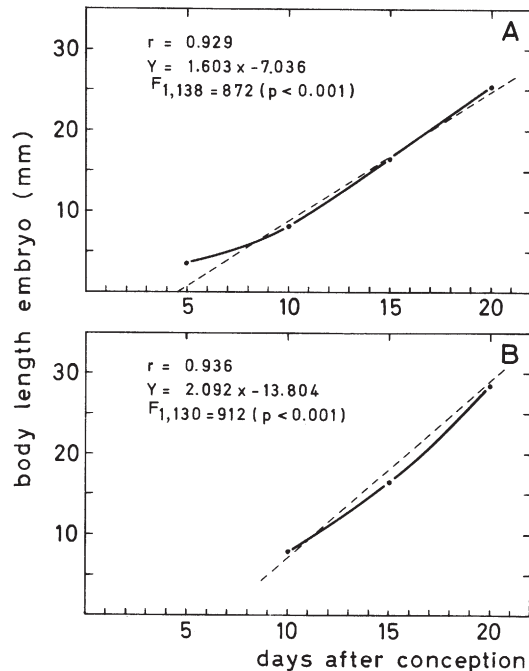


Fig. 1. Growth of embryo (length). Broken line — regression line. A. With foetal membranes. B. With foetal membranes removed. r: correlation coefficient. Significance of regression tested according to Draper & Smith (1966, p 24-25). ($F_{d1, d2}$: F-statistic with $d1$ and $d2$ degrees of freedom).

Tab. 3. Mean embryo length (with foetal membranes) and weight (without foetal membranes) at different litter sizes.

Days after conception	Mean embryo length (mm)							Mean embryo weight (g)							
	Litter size							Litter size							
	1	2	3	4	5	6	7	1	2	3	4	5	6	7	
5	—	—	2.3	3.7	—	—	—	—	—	—	—	0.05	—	—	—
10	5.0	5.5	5.7	5.7	8.7	10.8	8.4	0.2	0.5	0.7	0.1	0.2	0.2	0.1	
15	—	18.0	15.3	13.7	18.0	19.5	16.9	—	0.8	0.4	0.3	0.8	0.8	0.9	
20	—	—	25.7	26.3	24.4	26.1	21.7	—	—	3.9	3.0	2.0	2.9	1.6	

¹⁾ Not measured.

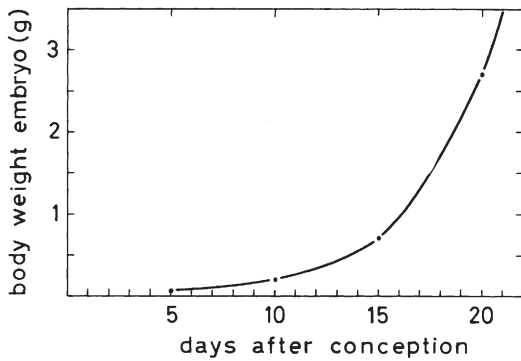


Fig. 2. Growth of embryo (weight).

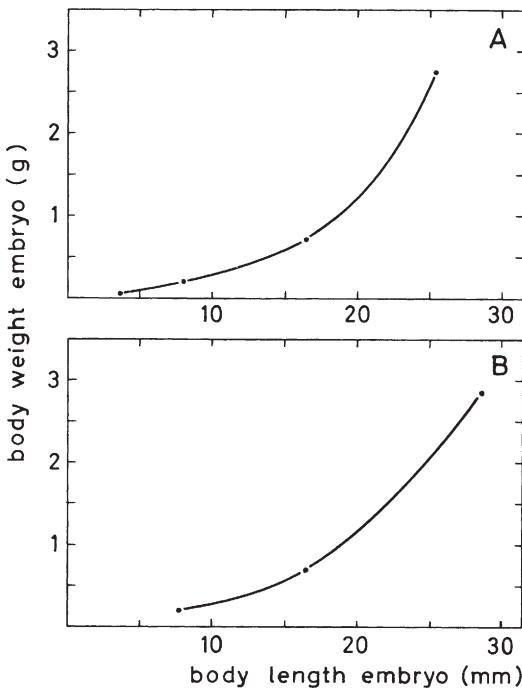


Fig. 3. Relation between embryonal body length and weight. A. With foetal membranes. B. With foetal membranes removed.

4.8 (Morrison et al. 1976) and 5.3 (Marcström 1966) are recorded. Our laboratory colony shows litter sizes from 4.0 ± 1.87 (C. E. Engh, unpubl.) to 3.4 and 3.2 in two freely growing confined populations, over a cyclic period of 65 and 85 weeks respectively (Semb-Johansson et

al. 1979). Even if the smaller mean litter size found in laboratory studies may indicate differences in breeding compared with wild animals, we believe our embryos to be representative of Norwegian lemmings, in nature or in captivity. The growth in this experiment shows a clear tendency to give the same mean length and weight values at birth as found in other studies (Frank 1962, Marcström 1966, Semb-Johansson et al. 1979, C.E. Engh unpubl.).

When dissecting out embryos younger than ten days from their membranes in an unfixed condition, they have a tendency to «shoot out of their compartment like a jack-in-the-box, and in doing so they usually recoil and become unduly stretched» (Gruneberg 1943). Gruneberg also states that the crown-rump length of a very gelatinous embryo of that age is a poor age guide and recommends that embryos are fixed either in utero or immediately after dissection, depending on the age, to avoid malformation. His recommendation is obviously valid for exact measurements. We believe, however, based on this study, that measurements of unfixed embryos give sufficient precision for field work when carrying out rapid autopsies on large numbers of animals.

Embryos of the Norwegian lemmings compared to the laboratory mouse (Enzmann 1935, Gruneberg 1943, Crispens 1975) and laboratory rat (Witschi 1962) grow more rapidly up to the age of ten days. From then on they grow at comparable speed, reaching slightly higher length and weight values than the mouse, and lower ones than the rat at birth.

The length of embryos, with foetal membranes, seem to form a fairly accurate age criterion as early as 5 days after conception. With the foetal membranes removed, the length measurement may be used from the 10th day on. Weight measurement gives a less accurate age determination in the period between 5 and 10 days after conception, but may be used when this uncertainty is kept in mind. By these age criteria it is possible to confirm pregnancy as early as 5 days after conception or estimate the age of elder embryos.

ACKNOWLEDGEMENTS

We wish to express our gratitude to G. Kneisel for help and advice with the breeding of the animals, J.M. Hoff for some of the calculations, M. Espeland, A. Semb-Johansson and N. Chr. Stenseth for critically reading the manuscript.

SAMMENDRAG

Prenatal vekst hos lemen

I et dyrestallforsøk ble laboratorieproduserte hanner og hunner av lemen satt sammen parvis i bur og adskilt etter at parring var observert. Hunnene ble deretter avlivet etter respektive 5, 10, 15 og 20 dagers svangerskap. Ialt ble benyttet 33 gravide hunner med 146 fostere. Den midlere kullstørrelsen var 4,42. Som kriterier på aldersutvikling av fostrene og derved en nøkkel til å bestemme hvorvidt mødrene var gravide ved disseksjoner under feltundersøkelser, eller hvor langt i svangerskapet de var kommet, ble brukt lengde og vekt på fostrene. Denne nøkkelten gjør det mulig å aldersbestemme dem etter lengde allerede 5 døgn og etter vekt mellom 5 og 10 døgn etter befruktning.

REFERENCES

- Crispens, C.G. jr. 1975. *Handbook on the laboratory mouse*. C.C. Thomas publ., Springfield and Illinois, 267 pp.
- Draper, N. & Smith, H. 1966. *Applied regression analysis*. J. Wiley & Sons, New York, London and Sidney, 407 pp.
- Enzmann, E.V. 1935. Intrauterine growth of albino mice in normal and in delayed pregnancy. *Anat. Rec.* 62, 31—45.
- Frank, F. 1962. Zur Biologie des Berglemmings, *Lemmus lemmus* (L.). Ein Beitrag zum Lemmingproblem. *Z. Morph. Ökol. Tiere* 51, 87—164.
- Gruneberg, H. 1943. The development of some external features in mouse embryos. *J. Heredity* 34, 88—92.
- Kalela, O. & Oksala, T. 1966. Sex ratio in the wood lemming, *Myopus schisticolor* (Lilljeb.), in nature and in captivity. *Ann. Univ. Turku AII.* 37, 1—24.
- Koshkina, T.V. & Khalansky, A.S. 1962. On the reproduction of lemming, *Lemmus lemmus*, on Kola Peninsula. *Zool. Zhur.* 41, 604—615.
- Marcstrøm, V. 1966. On the reproduction of the Norwegian lemming, *Lemmus lemmus* L. *Viltrevy* 4, 311—342.
- Morrison, P., Dietrich, R. & Preston, D. 1976. Breeding and reproduction of fifteen wild rodents maintained as laboratory colonies. *Lab. Anim. Sci.* 26, 237—243.
- Semb-Johansson, A., Wiger, R. & Engh, C.E. 1979. Dynamics of freely growing, confined populations of the Norwegian lemming, *Lemmus lemmus*. *Oikos* 33, 246—260.
- Wildhagen, Aa. 1953. *On the reproduction of voles and lemming in Norway*. Statens viltundersøkelser, Arbeidernes aktietrykkeri, Oslo, 61 pp.
- Witschi, E. 1962. Development: Rat, pp. 304—305. In: Altman, P. L. & Dittmer, D. S. (eds.) *Growth. VII. Prenatal Vertebrate Development*. Biological Handbooks of the Federation of American Societies for Experimental Biology, Washington.